Space Weather Technical Forecast

Issued on Thursday, 27 July 2023 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 radio blackouts likely. Chance of Active fluence later in the period.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Moderate with two M-class flares, both from AR3376 on the northwest limb. The peak flare was an M2.0 at 26/1559 UTC. This is one of 10 classified sunspot regions on the visible disc, with many of these stable or evolving slowly. At least three new regions have rotated across the eastern limb in the last 24 hours and will be fully analysed once it becomes easier to analyse them. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, measured at L1 has shown evidence of a solar sector boundary crossing (SSBC) at 26/1600 UTC along with residual effects of the CME arrival on 05 Jul. Solar wind speeds jumped sharply from 500 km/s to 575 km/s at 26/1600UTC, but has since steadily declined to 450 km/s. Density has been around average at between 6-10ppcc. Total magnetic field strength, Bt has been weak, but followed a steady trace, The north-south component, Bz, started persistently negative until 26/1600 UTC and has since become persistently, but weakly positive. Phi angle started negative (towards the Sun), but switched sharply to a positive orientation at 26/1600 UTC, which was the strongest indication of a SSBC. Geomagnetic activity started Unsettled, but weakened to Quiet.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels. GOES16 high energy (greater than 2MeV) electron flux oscillated between background to moderate throughout. The associated 24-hour integrated fluence was well below the Active threshold on a steady trend. Fluence was 5.28e6 integrated pfu at 27/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is forecast, with a slight chance of X-flares, most likely from AR3376.

Solar Wind / Geomagnetic Activity: A CME which arrived late on 25 Jul is likely to have been the early arrival of a feature which erupted from the Sun on 23 Jul. No further CMEs are expected within the forecast period. The Earth is now transitioning into a steady environment with CME and SSBC effects waning. A coronal hole high speed stream from coronal hole 28 may connect with the Earth on 28 Jul, with estimated speeds of 450-500km/s. Geomagnetic activity is expected to be mostly Quiet to Unsettled, perhaps with some Active intervals on 28 Jul due to the weak high speed stream connection.

Energetic Particles / Solar Radiation: There remains a slight chance of the high energy (greater than 10MeV) proton flux increasing from any further significant flares that occur. This risk reduces a little through the period as AR3376 rotates across the northwest limb. The high energy (greater than 2MeV) electron flux is likely to rise as wind speeds ease, with a chance of the associated fluence reaching Active (1e8 integrated pfu) levels later in the period.

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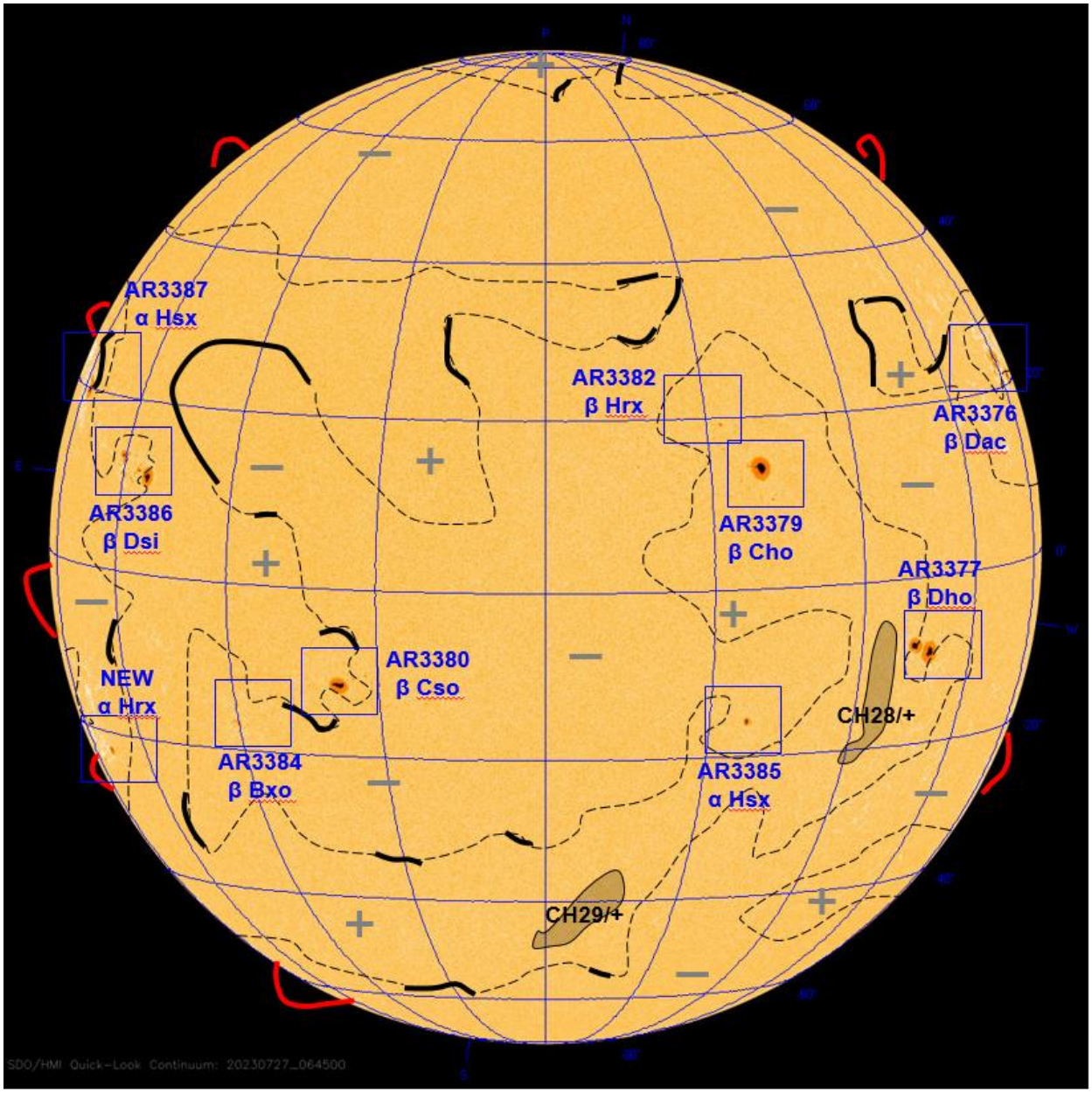
Figure 1. Solar Analysis Valid 27/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A CME which left the Sun on 23 Jul appears to have arrived late on 25 Jul, around 24 hours early. No further effects have been observed, with other candidates for this event discounted. There are no further CMEs forecast to arrive during the forecast period.

During the last 24 hours the Earth appears to have transitioned from the magnetic cloud and through a solar sector boundary crossing at approximately 26/1600 UTC. Following the transition, there is still some evidence of a post-CME magnetic cloud influence, with this likely to have been exited at 27/0600 UTC, evidenced by marked discontinuities across a number of solar wind parameters at L1.

A coronal hole high speed stream is then forecast to connect with Earth during 28 Jul, with speeds in the region of 450-500km/s. Analysis of both this, and the subsequent coronal hole 29, both positive polarity and in the southern hemisphere show weak features with any connection from coronal hole 28 likely to have limited effects.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, perhaps with an isolated Active interval on 28 Jul due to the coronal hole high speed stream connection.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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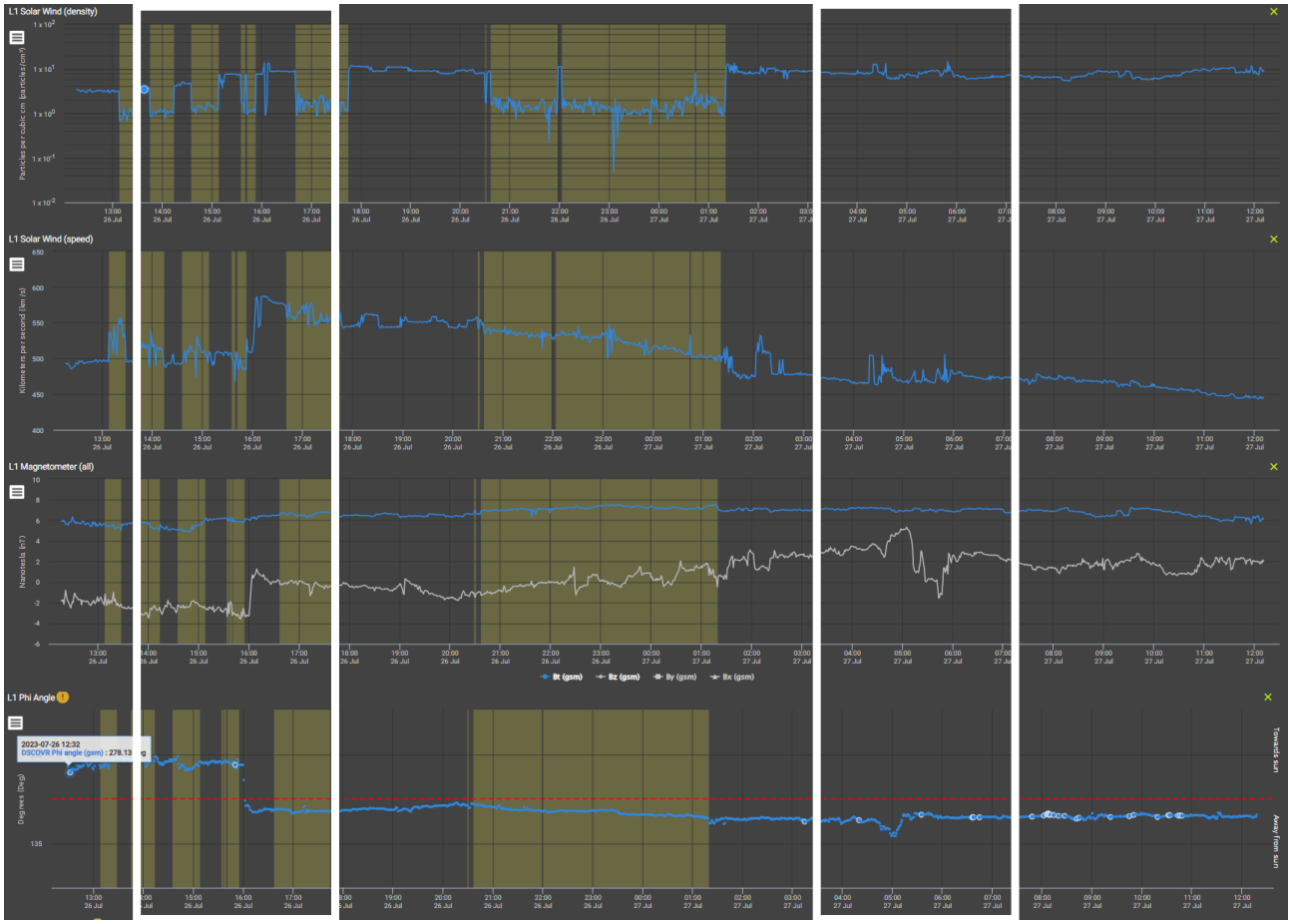
Figure 2: 24-hour solar wind parameters at L1. The left white box shows the SSBC described in the text and the right white box is the possible transition out of the CME magnetic cloud.



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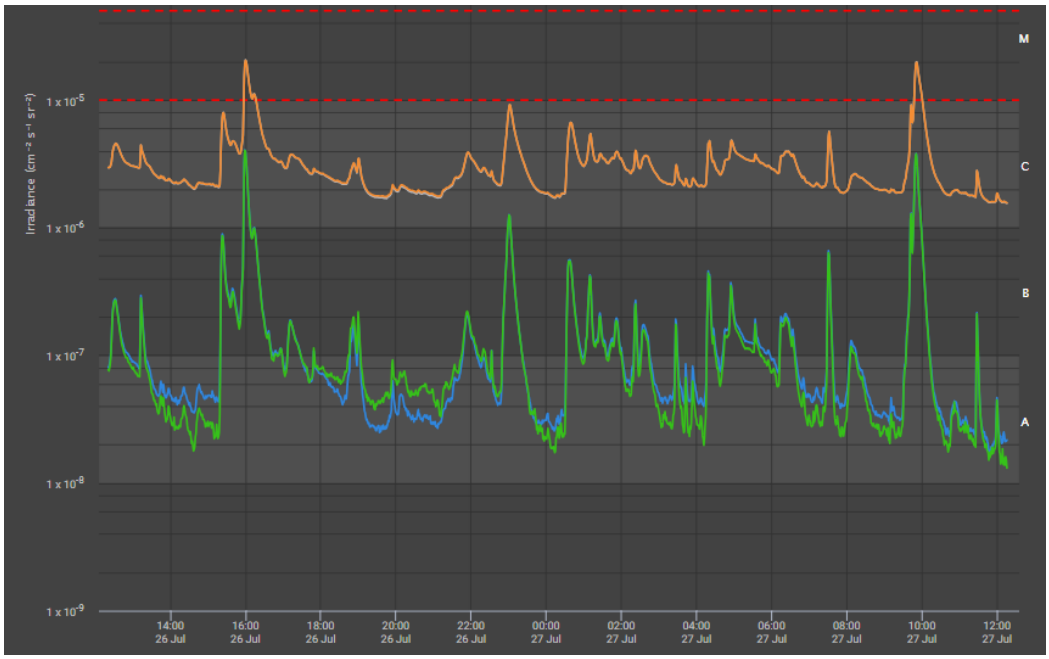
Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate through the last 24 hours, with both M-class flares originating from evolving region AR3376 close to the northwest limb, with a peak flare of M2.0 at 26/1559 UTC. This region is difficult to analyse magnetically due to foreshortening effects, but appears to contain more magnetically complexity then can be diagnosed. The remaining regions all appear relatively inactive, with limited evolution, although a number of regions are rotating onto the eastern limb, and will be monitored.

Solar activity is forecast to be Low to Moderate, with a decreasing risk as AR3376 rotates across the horizon. This may be reviewed in the forthcoming days as the appearance of the region in the east become more discernible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES 16 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is at background levels. There is a slight chance of further enhancements given any large flares, primarily from AR3376 or any of the other regions on the western disc. The probability reduces through the period as AR3376 rotates well away from the west limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) levels are beginning to increase modestly on diurnal highs following the subsidence in activity following the CME on 25 Jul. They are currently around moderate levels, with an increasing risk of reaching the high level later in the period, particularly if the coronal hole high speed stream connects with Earth on 28 Jul.

Electron fluence levels are on a rising trend, with the rate of this increase, and risk of exceeding the Active (1e8 integrated pfu) threshold, dependent on the potential high speed stream connection.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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